U.S. Fish & Wildlife Service

SPRING AND SUMMER CHINOOK SALMON SPAWNING GROUND SURVEYS ON THE ENTIAT RIVER, 2010

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***On the cover**: Summer Chinook salmon spawning in the Entiat River located within reach 2 (rm 25.8-23.4) on October 1, 2010. USFWS photograph by Mathew R. Hall.*

The correct citation for this report is:

Hamstreet, C.O. 2011. Spring and Summer Chinook Salmon Spawning Ground Surveys on the Entiat River, 2010. U. S. Fish and Wildlife Service, Leavenworth Washington.

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February, 2011

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Abstract-The Mid-Columbia River Fishery Resource Office conducted spring and summer Chinook salmon, *Oncorhynchus tshawytscha* spawning ground surveys on the Entiat River and tributary Mad River, from late August into mid-November 2010. A total of 204 spring Chinook salmon redds were identified. Using 2.4 fish per redd ratio, an estimated 490 spring Chinook salmon returned to spawn in the Entiat River.

One hundred eighty-two summer Chinook salmon redds were identified during the 2010 spawning ground surveys. Using 2.4 fish per redd ratio, an estimated 437 spring Chinook salmon returned to spawn in the Entiat River.

Surveyors identified 138 sockeye salmon redds, no bull trout or coho salmon redds were observed.

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INTRODUCTION

From 1962 to 1994, spring Chinook salmon, *Oncorhynchus tshawytscha*, spawning was monitored by the Washington Department of Fish and Wildlife (WDFW) in a seven-mile section of the Entiat River known as the "index area" (river mile (rm) 28.1 to 21.3). From 1957 to 1991, Chelan County Public Utility District monitored summer Chinook salmon spawning in the lower ten miles (rm 10.4 to 0) of the Entiat River. In 1994, the United States Fish and Wildlife Service (USFWS), Mid-Columbia River Fishery Resource Office (MCRFRO), began monitoring spring and summer Chinook salmon spawning more intensely on the Entiat River. Efforts in 2010 mark the 17th year that MCRFRO has conducted the expanded spawning surveys.

The objectives of the spawning surveys are to:

1. Continue to assess the distribution of spring and summer Chinook salmon spawning throughout the index and expanded areas of the Entiat & Mad rivers and provide estimates of the respective spawning populations.

2. Evaluate possible straying of hatchery spring and summer Chinook salmon.

3. Search for and note presence and/or redds of other species, which may include sockeye salmon, *O. nerka*, coho salmon, *O. kisutch*, bull trout, *Salvelinus confluentus* and Pacific lamprey, *Entosphenus tridentatus* and identify their spawning distribution in the survey sections.

STUDY AREA

The Entiat River Basin is located in Chelan County, north-central Washington State. The river originates in a glaciated basin of the Cascade Mountains and flows southeasterly. Base flow is 385 cubic feet per second (Mullan et al. 1992) and major tributaries are the North Fork (rm 34) and Mad River (rm 10.5). The upstream limit of anadromy is Entiat Falls (rm 33.8).

The Entiat system drains an area of about 416.5 square miles. The watershed is nearly 42 miles in length and varies in width from 5 to 14 miles. The basins highest elevation is the 9,249 foot summit of Mt. Fernow and its lowest is about 700 feet at the confluence with the Columbia River (USDA 1979). The Entiat River enters the Columbia River at approximately river mile 484 and eight main stem hydroelectric dams above the Pacific Ocean.

Spring and summer Chinook salmon spawning ground surveys were conducted on the Entiat River between Fox Creek Campground (CG) (rm 28.1) and the McKenzie Diversion Dam (rm 16.2) (Figure 1). An additional spring Chinook spawning ground survey was conducted on the Mad River between rm 1.5 and Pine Flats CG (rm 3.5). An additional summer Chinook survey was conducted on the lower Entiat River between the river mouth (rm 0.3) and Entiat National Fish Hatchery (rm 6.8).

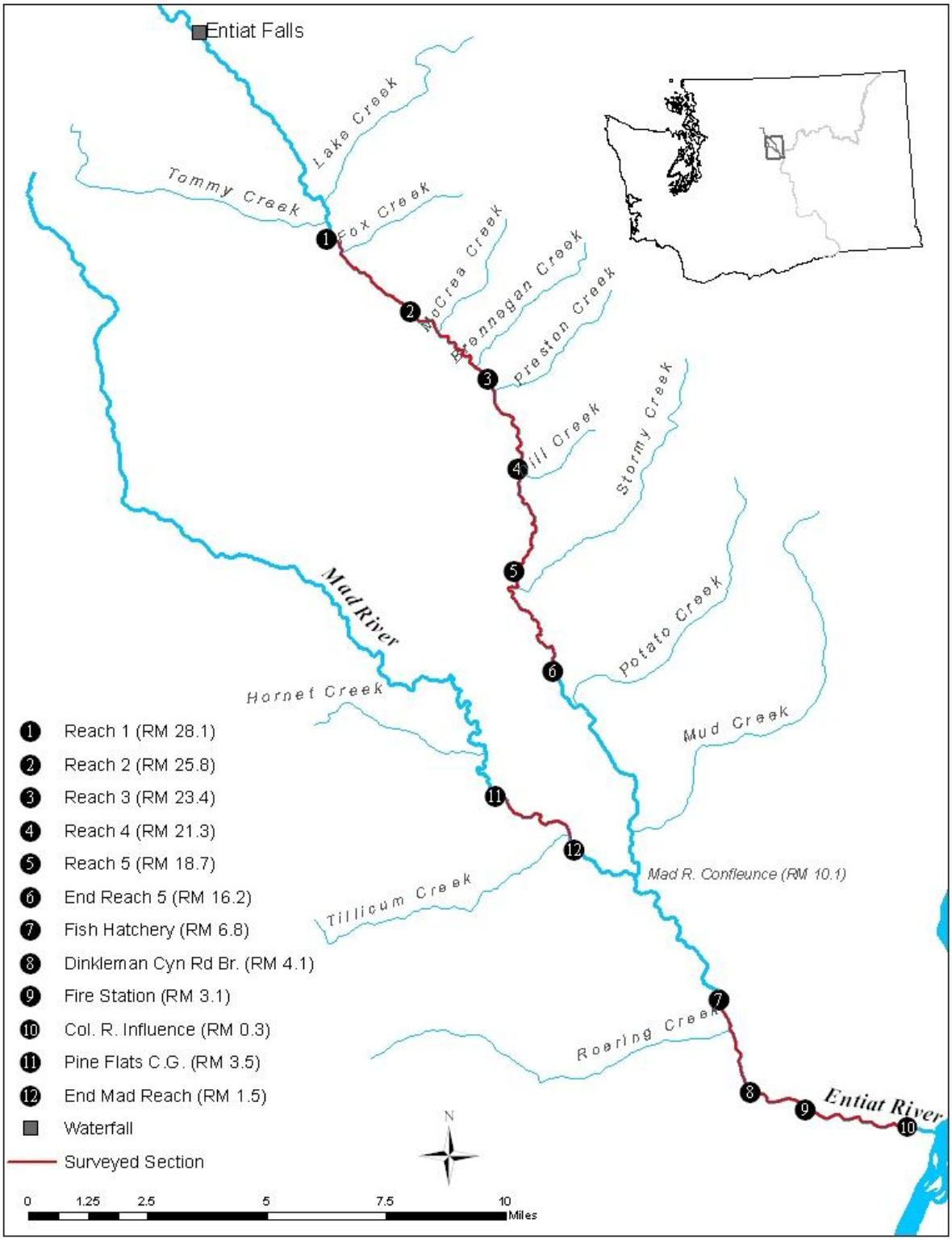

Figure 1. Overview of the Entiat River spawning ground survey areas.

SALMON AND BULL TROUT POPULATIONS

The Entiat River has historically supported excellent salmon runs consisting of Chinook (probably spring Chinook salmon) and coho salmon (Craig and Suomela 1941). Construction of dams around the turn of the century near the mouth of the Entiat River blocked salmon from their spawning grounds, and salmon runs were essentially nonexistent by 1939 when Grand Coulee Dam was built (Craig and Suomela 1941). From 1939 to 1943, as part of the Grand Coulee Fish Maintenance Project mitigation effort, all ascending adult salmon, mainly summer and fall Chinook salmon, were trapped at Rock Island Dam and relocated to upstream tributary streams below Grand Coulee Dam, including the Entiat River, and to hatcheries, including Leavenworth, Entiat, and Winthrop National Fish Hatcheries (NFH) (Fish and Hanavan 1948). The goal of these efforts was to rebuild salmon runs in the tributary streams and mitigate for lost production above Grand Coulee Dam.

Spring Chinook Salmon

In the initial years after Grand Coulee Dam was built, little effort was made to re-establish wild spring Chinook salmon runs in the Entiat River. From 1942 to 1944, Entiat NFH released a total of 1.3 million sub-yearlings and fewer than 50,000 yearling spring Chinook salmon that were offspring of the upriver stocks collected at Rock Island Dam (Mullan 1987). No spring Chinook salmon were released from Entiat NFH from 1945 to 1975. As early as 1956 and 1957, a wild spring Chinook salmon run was observed spawning in the area above Stormy Creek (rm 18.4) (French and Wahle 1960). Since 1962, spring Chinook salmon redds has been counted in an *index* area between river miles 28.1 and 21.3 where an established spring Chinook salmon run had been documented. Entiat NFH resumed spring Chinook salmon production in 1974. Egg sources have included Cowlitz River (1974), Carson NFH (1975 to 1982), Little White Salmon NFH (1976, 1978, 1979, 1981), Leavenworth NFH (1979-1981, 1994), and Winthrop NFH (1988). Adults that voluntarily returned to the hatchery were the primary brood stock in 1980 and from 1983 to 2006, after which the program was terminated.

Summer Chinook Salmon

Although summer Chinook salmon are not believed to be endemic to the Entiat River (Craig and Suomela 1941), several efforts were made to establish summer Chinook salmon in the Entiat River following completion of Grand Coulee Dam. In 1939 and 1940, a total of 3,015 adult summer Chinook salmon, collected at Rock Island Dam from the commingled upriver stocks, were placed in upper Entiat River spawning areas. Only an estimated 1,308 of these survived to spawn (Fish and Hanavan 1948). Entiat NFH reared and released juvenile summer Chinook salmon into the Entiat River from 1941-1964, and 1976 (Mullan 1987). After cessation of spring Chinook program in 2006 a summer Chinook program was reinitiated in 2009 with the first release scheduled to occur in 2011. Egg sources included the commingled upriver stocks intercepted at Rock Island Dam (1939-1943), Methow River (1944), Carson NFH (1944), Entiat River (1946-1964), Spring Creek NFH (1964), and Wells Dam (1974) and (2009-2010). Summer Chinook salmon spawning was monitored by aerial surveys in the lower 10.4 river miles from 1957 to 1991. Positive redd identification from the air is difficult at best; therefore aerial surveys likely underestimated actual redd numbers. Spawning numbers were never high, with a maximum of 55 redds in 1967. For years 1972-1991, aerial redd counts averaged about five per year. MCRFRO has conducted surveys in the upper river (rm 28.1-16.2) by foot since 1994 and on the lower River (rm 6.8-0.3) by raft since 2006.

Bull Trout, **Sockeye Salmon and Coho Salmon**
Bull trout presence/absence surveys were conducted in 1984 and 1987, with limited data obtained (WDFW 1997). In 1989, the United States Forest Service (USFS) contracted with WDFW to determine bull trout distribution and abundance within the Wenatchee National Forest, including the Entiat River main-stem and Mad River (Brown, 1993). Incidental sightings of bull trout (1993 to 2005) have also been recorded by USFS personnel (Archibald P., and E. Johnson, 2007) from Entiat Falls to the gauging station pool (rm 33.8 to 33.5). MCRFRO began surveying for bull trout and for redds in 1994 during spring and summer Chinook salmon spawning ground surveys. In 2004, MCRFRO expanded the bull trout redd survey area to include gauging station pool (rm 33.5) to Fox Creek C.G. (rm 28.1).

Sockeye salmon are not indigenous to the Entiat River (Craig and Suomela 1941), and have only been stocked on two occasions (1943 and 1944), from Lake Quinault and Lake Whatcom stocks (Mullan 1986). A small run of sockeye salmon became established in the Entiat River and Entiat NFH collected sockeye salmon from 1944 to 1963, and their progeny were planted elsewhere (Mullan 1986).

Coho salmon runs had been largely extirpated in the Mid-Columbia River prior to 1941 (Mullan 1983). Propagation of coho salmon at the Mid-Columbia Federal hatcheries began in the 1940s and extended into the early 1970s. Chelan and Douglas County Public Utility Districts, in cooperation with WDFW, started propagation of coho salmon in the 1970's and continued until 1994. In 1996, the Yakama Nation initiated the Mid-Columbia Coho Restoration Program, which reintroduced the species into the Wenatchee and Methow sub-basins. Although no releases have occurred in the Entiat River, coho salmon have been observed in the Entiat River since 2001.

METHODS

Spring and Summer Chinook Salmon Redd Surveys
Redd surveys consisted of dividing the survey area into several reaches and were surveyed multiple times by walking or rafting downstream. Each encountered redd of both runs were numbered sequentially, number of live fish were recorded and redds were marked with colored flagging hung on nearby vegetation. Hand held Global Position System (GPS) units recorded Latitude and longitude positions for each redd. Recovered carcasses were measured from snout tip to fork in tail (fork length) and post orbital to hypural plate (POH), gender identified, females were dissected and visually ranked (complete/partial/incomplete or unknown) for spawning success and scale samples were collected when possible. Scales were viewed using a microfiche reader to determine age and origin (wild or hatchery). Carcasses were examined for tags and marks, scanned for the presence of coded-wire tags (CWT) and passive integrated transponder (PIT) tags. Snouts were removed from carcasses with detected CWT's for later retrieval and de-coding of CWT. Detected PIT tags were download using a portable transceiver and uploaded to PTAGIS. Tissue samples were taken for future DNA analysis and the tail was removed to prevent re-counting.

Bull Trout, **Sockeye and Coho Salmon**
During the Chinook salmon spawning ground surveys, observed bull trout, sockeye and coho salmon and redds were recorded and marked when identified by the presence of fish and size of redd.

Estimating River Escapement by Fish/Redd Ratio
Estimating escapement for spring Chinook salmon returning to the Entiat River was calculated by expanding redd counts using the expansion value of 2.4 fish per redd. Mullan, (1990), used a spawner/redd ratio of 2.4 to account for pre-spawning mortality. To estimate return escapement for summer Chinook, the expansion value of 2.4 fish/redd was also applied.

Scale Analysis and Age Designation
Scales were used to identify fresh and salt water growth periods and determine hatchery or wild origin. Wild summer Chinook scales exhibit three distinct freshwater life histories, age 0, age 1 reservoir reared and age 1 river reared, (per comm. John Sneva, WDFW). Age designation in this report follows the Gilbert and Rich (1927) system, where total age is referenced by the first digit and age at the time of migration from freshwater is indicated by the subscript.

Estimating Coded-Wire Tag Expansions for Spring and Summer Chinook
Recovered carcasses with a CWT generally only represent a portion of the population. In order to estimate the potential total number of adults represented by a particular recovered CWT, we expanded by using the number of examined recovered carcasses, divided by the estimated number of returning fish, yielded a sample rate. To calculate the expanded coded-wire tag recoveries for each tag code recovered, divide the number of coded-wire tags recovered by the sample rate and divide that figure by the release group coded-wire tag percent.

Female Carcass Egg Voidance Determination
Egg voidance from female carcasses was determined by visual estimation; complete (99% void of eggs), partial (98%-11% void of eggs), incomplete (10% or less void of eggs) and unknown (carcasses compromised).

RESULTS

Spring Chinook Salmon Redd Counts
A total of **204** spring Chinook salmon redds were identified during the 2010 spawning ground surveys (Table 1). This was 152% greater than the 10 year average of 134. The number of redds per reach in 2010 and the ten year running totals are found in Figure 2. One hundred twenty-five redds were counted in the old *index* area. Annual redd counts from the old *index* area are found in Appendix 1. Seventy-nine redds were found in the expanded survey area of which 12 redds were counted in the Mad River.

Spring Chinook Salmon Escapement
The total spring Chinook salmon redd count was 204 and using the 2.4 fish per redd ratio, an estimated **490** spring Chinook salmon returned to spawn in the Entiat River.

Spring Chinook Salmon Sex Ratio and Spawning Success
Ninety-three spring Chinook salmon carcasses were recovered during the spawning ground surveys, 59% (55) were females, and 41% (38) were males. All 55 female carcasses were examined for spawning success, 47 were fully voided, 1 was partial and 7 could not be determined because of carcass decomposition. From the 93 recovered carcasses 84 DNA samples were collected and sent to Abernathy Fish Technology Center for archival and future analyses.

Table 1.Spring Chinook salmon spawning ground surveys on the Entiat and Mad Rivers in 2010.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Old *Index* Area					
Reach 1	28.1-25.8	8/23/2010	20	17	0
		8/30/2010	8	20	1
		9/07/2010	7	11	3
		9/13/2010	3	0	0
		9/23/2010	2	2	0
		9/29/2010	0	0	**a** 1
		10/18/2010	0	0	**b** 1
Cumulative Total Count			40	50	6
Reach 2	25.8-23.4	8/23/2010	18	18	2
		8/30/2010	31	59	5
		9/08/2010	7	28	12
		9/15/2010	2	2	6
		9/21/2010	0	0	1
Cumulative Total Count			58	107	26
Reach 3	23.4-21.3	8/24/2010	12	26	2
		8/31/2010	11	15	1
		9/09/2010	4	8	2
		9/16/2010	0	0	3
		9/22/2010	0	0	0
Cumulative Total Count			27	49	8
Old Index Total			125	206	40
Expanded Area					
Reach 4	21.3-18.7	8/26/2010	20	12	1
		9/01/2010	5	20	6
		9/07/2010	11	15	9
		9/13/2010	0	0	2
		9/14/2010	0	0	**c** 2
		9/16/2010	0	0	**d** 2
		9/22/2010	0	0	**e** 3
		9/24/2010	0	0	0
		10/21/2010	1	0	**f** 0
Cumulative Total Count			37	47	25
Reach 5	18.7-16.2	8/26/2010	2	9	0
		9/01/2010	8	20	2
		9/09/2010	17	8	7
		9/15/2010	2	1	8
		9/23/2010	0	0	1
		9/27/2010	1	1	4
Cumulative Total Count			30	39	22
Mad	3.5-1.5	9/04/2010	9	6	0
		9/11/2010	3	1	1
		9/18/2010	0	0	1
		9/24/2010	0	0	1
	1.5-0.0	9/25/2010	0	0	1
Cumulative Total Count			12	7	4
Rotary Screw Trap	1.0	9/14/2010			1
		9/22/2010			1
Cumulative Total Count					2
Expanded Total			79	93	53
Index Total			125	206	40
Total			204	299	93

a) Carcass recovered during SUS SGS on 9/29. **b**) Carcass recovered during SUS SGS on 10/18. **c**) Carcasses recovered during SCS redd imposition survey on 9/14. **d**) Carcasses recovered during SCS redd imposition survey on 9/16. **e**) Carcasses recovered during SCS redd imposition survey on 9/22. **f**) Carcass recovered during SUS SGS on 10/21.

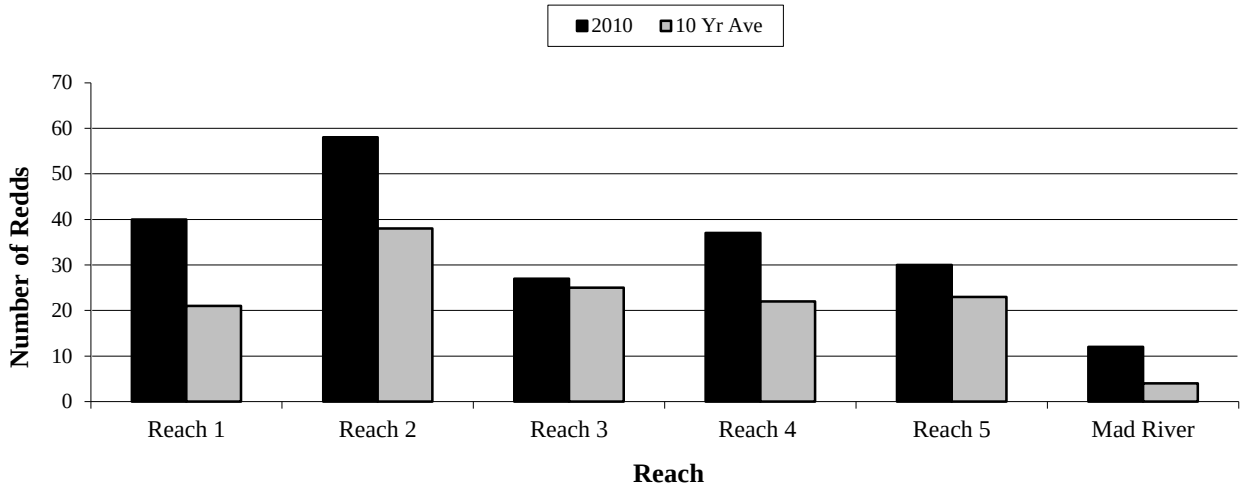

Figure 2. Entiat River spring Chinook salmon redd counts for Reaches 1-5 and Mad River for year 2010 and 10 year average.

Spring Chinook Salmon Age Composition and Origin

Of the 93 spring Chinook salmon carcasses recovered, age and origin were successfully determined for 84 (Table 2). Hatchery fish comprised 25% of the recovered carcasses. The percent composition of hatchery vs. wild in the Entiat River for years 2001–2010 are found in Figure 3.

Coded-Wire Tag Recoveries from Spring Chinook Salmon Carcasses

Of the 93 recovered carcasses from the Entiat River 87 were checked for missing adipose fins and scanned with a portable handheld wand detector for coded-wire tags. Sixteen (18%) were identified as having a missing adipose fin, of which 10 had a coded-wire tag (Table 3). Note: Ten carcasses could not be identified as having an adipose fin present or missing

Passive Integrated Transponder Tag Recoveries from Spring Chinook Salmon Carcasses

Of the 93 recovered carcasses from the Entiat River 87 were scanned with a portable transceiver for PIT tags. Seven (8%) were identified as containing a PIT tag (Table 4).

Table 2. Age composition and origin for spring Chinook salmon sampled from the Entiat River in 2010.

		Male	Female		
Origin	Age	(N)	(N)	Total (N)	%
Hatchery	3/2	2	1	3	3.5
	4/2	4	11	15	18.0
	5/2	2	1	3	3.5
		8	13	21	25.0
Wild	3/2	2	0	2	2.0
	4/2	19	31	50	60.0
	5/2	6	5	11	13.0
		27	36	63	75.0
Total		**35**	**49**	**84**	**100**

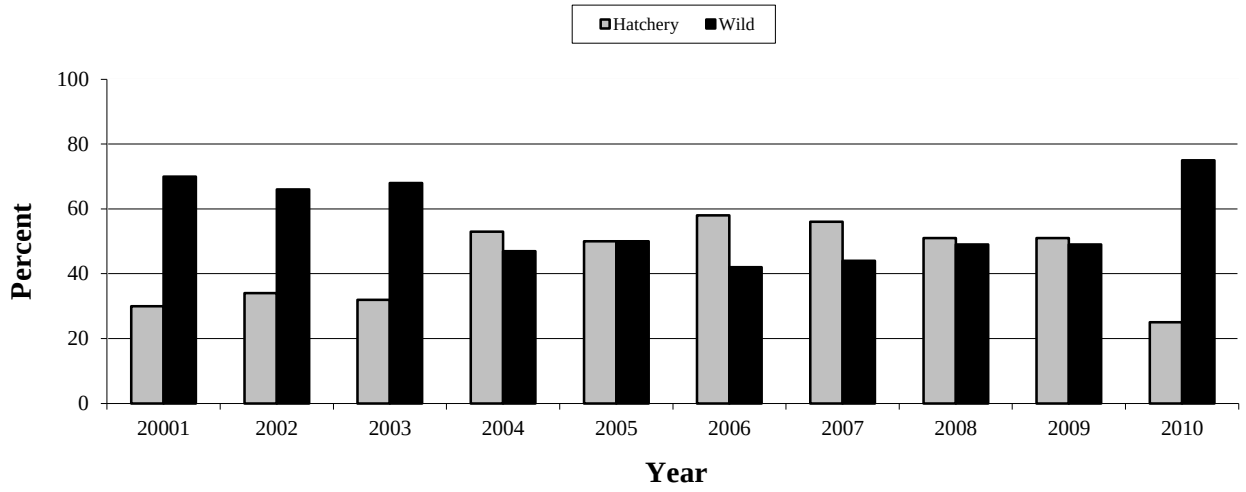

Figure 3. Estimated percent composition of hatchery vs. wild spring Chinook salmon escapement into the Entiat River, 2001-2010.

Table 3. Coded-wire tag recoveries collected from spring Chinook salmon carcasses on the Entiat River in 2010.

Tag Code	Brood Year	Release Agency	Hatchery	Recovered	Sample Rate %	% CWT'd at release	Expanded Recoveries
053171	05	USFWS	Entiat NFH	1	19.0	47	11
053180	06	USFWS	Winthrop NFH	2	19.0	99	11
054133	06	USFWS	Dworshak NFH	1	19.0	99	5
612713	06	NEZP	NPT Hatchery	1	19.0	99	5
633864	06	WDFW	Chiwawa R.P.	1	19.0	99	5
633866	05	WDFW	Methow SFH	1	19.0	99	5
633884	05	WDFW	Chewuch Accl	1	19.0	98	5
634290	07	WDFW	Chiwawa R.P.	1	19.0	99	5
634291	07	WDFW	Chiwawa R.P.	1	19.0	99	5
Total				**10**			**57**

Table 4. Passive Integrated Transponder Tag interrogations from spring Chinook salmon carcasses on the Entiat River in 2010.

PIT Tag Code	Sex	Release Site	Release Date	Last Detection Site	Last Detection Date
3D9.1C2D8CFE2C	F	Priest Dam	05/19/10	Rocky Reach Dam	05/25/10
3D9.1C2C30F4E1	M	Entiat River	10/29/07	Rocky Reach Dam	06/19/10
3D9.1C2C47DE6E	M	Entiat River	04/29/08	Entiat Upper Array	07/03/10
3D9.1C2D8D256D	F	Priest Dam	05/11/10	Entiat Upper Array	05/30/10
3D9.1C2D023720	M	Below Bonn.	05/08/10	Rocky Reach Dam	05/27/10
3D9.1C2D60DE54	F	Wells Dam	06/09/10	Entiat Upper Array	07/17/10
3D9.1C2C44B21B	M	Entiat River	04/13/08	Entiat Upper Array	09/06/10

Summer Chinook Salmon Redd Counts
A total of **182** redds were counted in reaches 1 through 5, Mad/Entiat River confluence and Entiat NFH to the Columbia River influence in 2010 (Table 5). This was 121% greater than the five year average of 150. The number of redds per reach in 2010 and the ten year running totals are found in Figure 4.

Summer Chinook Salmon Escapement
The total summer Chinook salmon redd count was 182, and using the 2.4 fish per redd ratio, an estimated **437** summer Chinook salmon returned to spawn in the Entiat River. This estimate should be considered a minimum since not all portions of the Entiat River were surveyed.

Summer Chinook Salmon Sex Ratio and Spawning Success
Ninety-three summer Chinook salmon carcasses were recovered in 2010, 68% (63) were females and 32% (30) were males. All 63 female carcasses were examined for spawning success; 71% (45) were complete, 3% (2) were partial, 10% (6) incomplete and 16% (10) were not sampled due to carcass decomposition.

Summer Chinook Salmon Age Composition and Origin
Of the 93 summer Chinook salmon carcasses recovered, age and origin were successfully determined for 90. Summary of age composition for hatchery and wild fish are found in Table 6. Hatchery origin fish comprised 23.2 % of the recovered carcasses compared to wild origin of 76.8%. The percent composition of hatchery vs. wild in the Entiat River for years 2001–2010 is found in Figure 5. Estimated percent composition of hatchery vs. wild summer Chinook salmon spawning in the upper reaches (above rm.16.2) compared to the lower reaches (mainly below hatchery) in 2010 and the ten year average are found in Figure 6. Three juvenile life history types were identified for wild summer Chinook salmon, 69.6% migrated to saltwater at age 0, while 29.0% over wintered in the reservoir and 1.4% in the tributary, entering saltwater at age 1. Juvenile life history numbers and percentages for years 2006-2010 are found in Table 7.

Coded-Wire Tag Recoveries from Summer Chinook Salmon Carcasses
Of the 93 recovered carcasses from the Entiat River 90 were checked for missing adipose fins and scanned with a portable handheld wand detector for coded-wire tags. Eighteen carcasses were identified as having a missing adipose fin, of these, 17 contained a CWT (Table 8).

Bull Trout, Sockeye and Coho Salmon
Surveyors identified, counted and/or recovered 138 sockeye salmon redds, 329 live and 19 carcasses. No bull trout or coho salmon redds, carcasses or live fish were observed.

Coded-Wire Tag Recoveries from Sockeye Salmon Carcasses
All recovered sockeye salmon carcasses were checked for missing adipose fins and scanned with a portable handheld wand detector for coded-wire tags. Ten sockeye carcasses were identified as missing an adipose fin of which nine contained a coded-wire tag (Table 9).

Passive Integrated Transponder Tag Recoveries from Sockeye Salmon Carcasses
Nineteen recovered carcasses from the Entiat River were scanned with a portable transceiver for PIT tags. Two (11%) were identified as containing a PIT tag (Table 10).

Table 5. Summer Chinook spawning ground surveys on the Entiat and Mad River in 2010.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Reach 1	28.1-25.8	09/29/10	3	0	0
		10/18/10	6	0	1
Cumulative Total Count			9	0	1
Reach 2	25.8-23.4	10/01/10	11	12	0
		10/14/10	5	4	1
Cumulative Total Count			16	16	1
Reach 3	23.4-21.3	10/01/10	2	0	0
		10/14/10	6	0	0
Cumulative Total Count			8	0	0
Reach 4	21.3-18.7	09/28/10	1	4	0
		10/13/10	11	9	1
		10/21/10	4	1	1
		10/27/10	2	0	3
		10/29/10	3	2	1
Cumulative Total Count			21	16	6
Reach 5	18.7—16.2	09/21/10	0	0	**a** 1
		09/27/10	8	87	0
		10/15/10	77	86	19
		10/28/10	5	8	35
		11/01/10	0	0	**b** 2
		11/09/10	0	0	1
Cumulative Total Count			90	181	58
Upper River Total			**144**	**213**	**66**
Entiat R.at Mad R. Confluence	10.1	11/05/10	1	1	0
Entiat NFH to Fire Station	6.8-3.1	10/20/10	11	8	0
		11/03/10	2	1	7
Cumulative Total Count			13	9	7
Fire Station to Columbia River Influence	3.1-0.3	10/21/10	21	37	3
		11/05/10	3	3	14
		10/26/10	0	0	**c** 1
		11/01/10	0	0	**c** 2
Cumulative Total Count			24	40	20
Lower River Total			**38**	**50**	**27**
Upper River Total			**144**	**213**	**66**
TOTAL			**182**	**263**	**93**

a) Summer Chinook carcass recovered during redd imposition survey on 09/21/10. **b**) Summer Chinook carcass recovered during redd imposition survey on 11/01/10 **c**) Entiat field station crew collected and bio-sampled summer Chinook carcasses recovered at the rotary screw trap located at river mile 1.0.

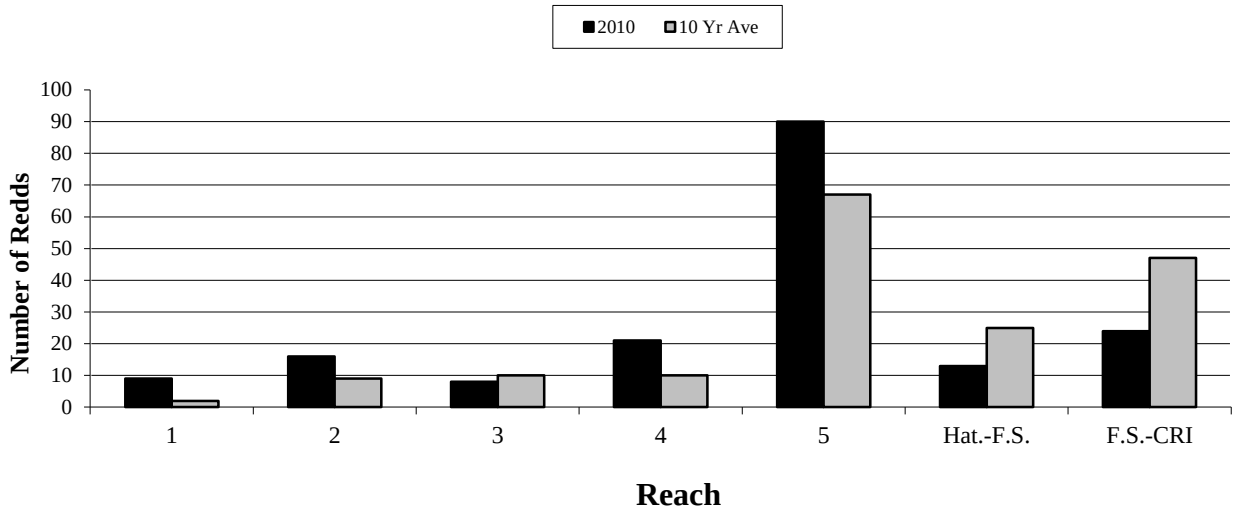

Figure 4. Entiat River summer Chinook salmon redd counts for Reaches 1-5, Entiat NFH to Fire Station and Fire Station to Columbia River influence for 2010 and 10 year average. Note: Reach 1 was not surveyed in 2001 and 2005 and Entiat NFH to Dinkleman Cyn. Rd. Bridge (rm. 6.8-4.1) was not surveyed from 2001-2005.

Table 6. Age composition and origin for summer Chinook salmon sampled from the Entiat River in 2010.

Male						Female					
Origin	Age	(N)	%	Reservoir Reared	River Yearling	(N)	%	Reservoir Reared	River Yearling	Total (N)	Total %
Hatchery	3/1	0	0.0			1	1.1			1	1.1
	3/2	0	0.0			0	0.0			0	0.0
	4/1	0	0.0			1	1.1			1	1.1
	4/2	2	2.2			9	10.0			11	12.2
	5/1	0	0.0			1	1.1			1	1.1
	5/2	1	1.1			4	4.4			5	5.5
	6/2	0	0.0			2	2.2			2	2.2
		3	3.3			18	19.9			21	23.2
Wild	3/1	6	6.7			0	0.0			6	6.7
	3/2	0	0.0			0	0.0			0	0.0
	4/1	9	10.0			10	11.2			19	21.2
	4/2	4	4.4	*4*		2	2.2	*2*		6	6.6
	5/1	4	4.4			17	19.0			21	23.4
	5/2	2	2.2	*1*	*1*	13	14.5	*13*		15	16.7
	6/1	0	0.0			2	2.2			2	2.2
	6/2	0	0.0			0	0.0			0	0.0
		25	27.7			44	49.1			69	76.8
Total		**28**	31%			**62**	69%			**90**	100%

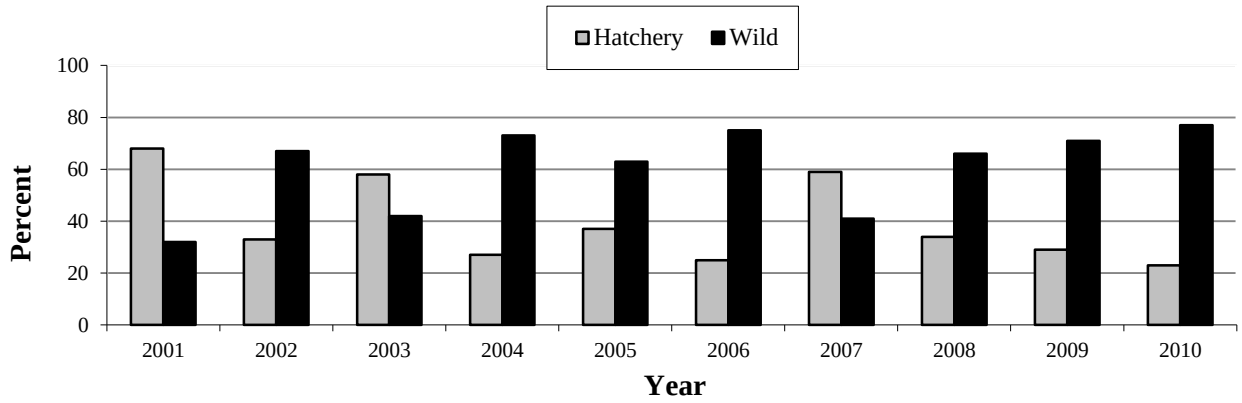

Figure 5. Estimated percent composition of hatchery vs. wild summer Chinook salmon escapement into the Entiat River, 2001-2010.

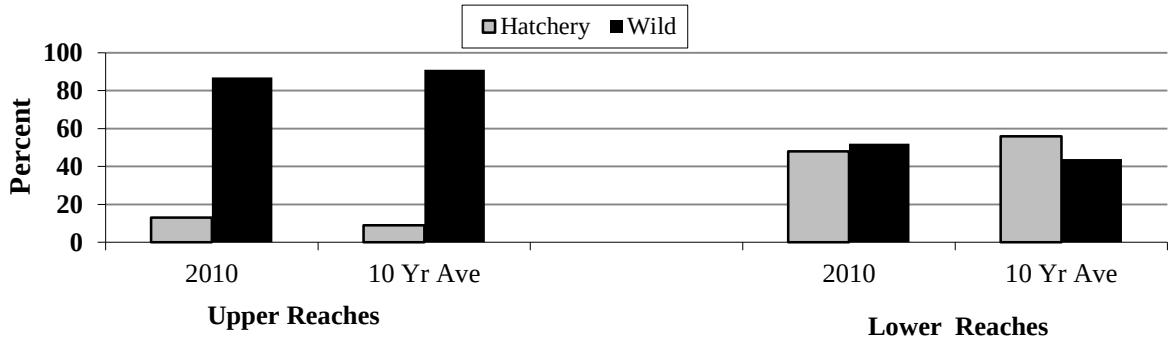

Figure 6. Estimated percent composition of hatchery vs. wild summer Chinook salmon spawning in the upper reaches (above RM. 16.2) compared to the lower reaches (mainly below hatchery) in 2010 and the ten year average.

Table 7. Juvenile life history numbers and percentages for summer Chinook salmon sampled from the Entiat River in years 2006-2010.

Year	Ocean		Reservoir		Tributary	
	#	%	#	%	#	%
2006	88	73.3%	27	22.5%	5	4.2%
2007	24	68.6%	10	28.6%	1	2.9%
2008	44	83.0%	8	15.1%	1	1.9%
2009	46	82.1%	10	17.9%	0	0.0%
2010	48	69.6%	20	29.0%	1	1.4%

Table 8. Coded-wire tag recoveries collected from summer Chinook salmon carcasses on the Entiat River in 2010.

Tag Code	Brood Year	Release Agency	Hatchery	Recovered	Sample Rate %	% CWT'd at release	Expanded Recoveries
633094	04	WDFW	Columbia River	1	21.3	98	5
633165	04	WDFW	Wenatchee R.	1	21.3	98	5
633592	05	WDFW	Dryden Pond	2	21.3	98	10
633595	05	WDFW	Chelan R.	2	21.3	99	9
633596	05	WDFW	Wells SFH	1	21.3	99	5
633799	06	WDFW	Columbia River	1	21.3	99	5
633881	06	WDFW	Turtle Rock SFH	1	21.3	100	5
633895	06	WDFW	Lake Chelan	3	21.3	99	7
633896	07	WDFW	Columbia River	1	21.3	99	5
634184	06	WDFW	Wenatchee River	4	21.3	98	19
Total				**17**			**75**

Table 9. Coded-wire tag recoveries collected from sockeye salmon carcasses on the Entiat River in 2010.

Species	Tag Code	Brood Year	Release Agency	Hatchery	Recovered
Sockeye	633865	06	WDFW	LK Wenatchee	9

Table 10. Passive Integrated Transponder Tag interrogations from sockeye salmon carcasses on the Entiat River in 2010.

PIT Tag Code	Sex	Release Site	Release Date	Last Detection Site	Last Detection Date
3D9.257C5B2BFC	M	Wenatchee R.	10/31/2007	Entiat Upper Array	08/06/2010
3D9.1C2C83FD03	M	Wenatchee R.	05/14/2008	Entiat Lower Array	09/10/2010

SUMMARY

The total number of spring Chinook redds counted during the 2010 spawning ground surveys was 204 (Figure 7), which included 125 redds in the old index area and 79 redds found in the expanded section. Using the 2.4 fish per redd ratio and the total redd count of 204, an estimated 490 spring Chinook salmon returned to spawn in the Entiat River. Ninety-three carcasses were recovered and examined, of these, 59% were female and 41% male. All spring Chinook salmon females were 100% spawned. Hatchery origin comprised 25% compared to wild origin of 75%. A total of 10 coded-wire tags were recovered; Entiat NFH (1), Winthrop NFH (2), Dworshak NFH (1), Nez Perce Hatchery (1), Chiwawa Rearing Ponds (3), Methow SFH (1) and Chewuch Acclimation Pond (1).

The total number of summer Chinook redds counted during the 2010 spawning ground surveys was 182 (figure 7), which included 144 (79%) in Reaches 1-5 and 38 (21%) located below river mile 16.2. Using the 2.4 fish per redd ratio and the total redd count of 182, an estimated 437 summer Chinook salmon returned to spawn in the Entiat River. Ninety-three carcasses were recovered and examined, of which 68% were females and 32% males. All female carcasses recovered were examined for spawning success; 71% were complete, 3% were partial, 10% were incomplete and 16% were unknown due to carcass decomposition. Hatchery origin fish comprised 23% of the population compared to wild origin of 77%. Scale analysis revealed wild summer Chinook had three distinctive freshwater life histories; 70% were sub-yearling migrants, 29% were reservoir reared yearling migrants and 1% was tributary reared yearling migrants. A total of seventeen coded-wire tags were recovered; Dryden Acclamation Pond (2), Turtle Rock SFH (1), Columbia River general (3), Wenatchee River (5), Chelan River (2), Lake Chelan (3) and Wells SFH (1).

During the spring and summer Chinook spawning ground surveys, surveyors identified, counted and/or recovered 138 sockeye salmon redds, 329 live and 19 carcasses. No bull trout or coho salmon redds were observed.

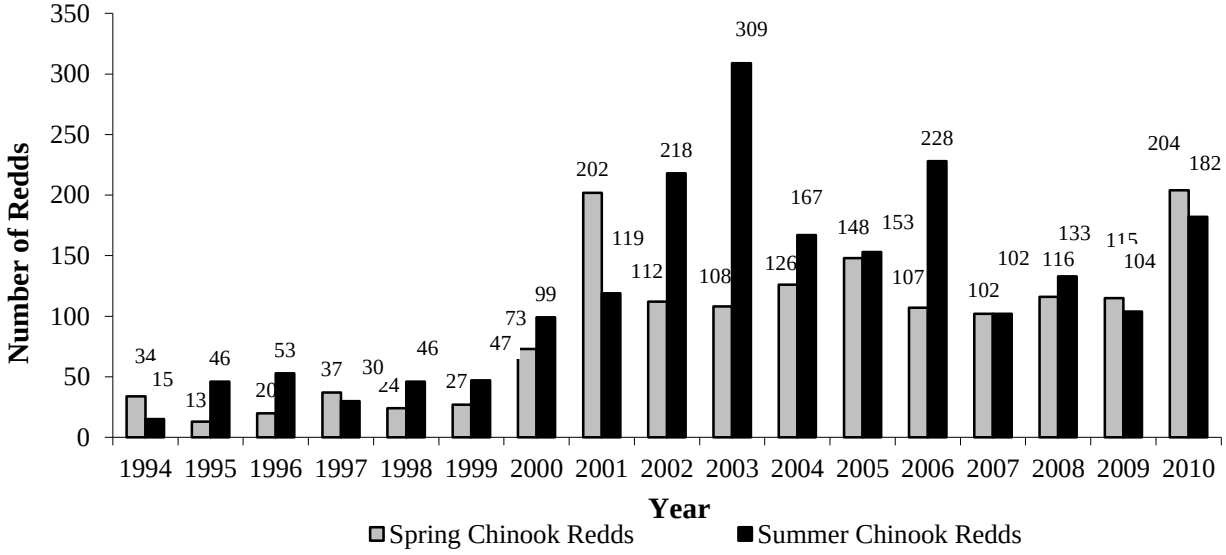

Figure 7. Spring and summer Chinook salmon redd counts for the Entiat River, 1994 to 2010.

ACKNOWLEDGMENTS

Thanks to the following individuals for their assistance with the spawning ground surveys: Tom Desgrosiellier, Tara Taylor, Jonah Terrell-Lewis, Robbette Schmit, Matt Hall, Matt Cooper, Fredy Quesada, Armin Halston, Kyle Fronte, Heather Trainer, and Craig Chisam. I would also like to thank Andy Johnsen for map formation, Matt Cooper for all his data analysis and Jim Craig for reviewing the draft report.

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APPENDIX 1

Entiat River spring Chinook salmon redd counts from annual surveys in old *index* area, Fox Creek C. G. to Dill Creek (RM 28 to 21), 1962-1993 (WDFW) and 1994-2010 (USFWS).

YEAR	#of REDDS	YEAR	#of REDDS	YEAR	#of REDDS	YEAR	#of REDDS
1962	115	1975	156	1988	67	2001	144
1963	145	1976	47	1989	37	2002	72
1964	384	1977	171	1990	83	2003	70
1965	104	1978	326	1991	32	2004	65
1966	307	1979	NA	1992	42	2005	81
1967	252	1980	107	1993	100	2006	65
1968	252	1981	95	1994	24	2007	70
1969	83	1982	107	1995	1	2008	77
1970	70	1983	107	1996	8	2009	76
1971	136	1984	84	1997	20	2010	125
1972	61	1985	115	1998	15		
1973	229	1986	105	1999	6		
1974	88	1987	64	2000	28		

N/A= not available

APPENDIX 2

River mile index of the Entiat River from the mouth to Entiat Falls.

River Mile	Description
0.0	Mouth of Entiat River at river-mile 483.7 on Columbia River
0.3	Columbia River influence
1.5	Keystone Bridge
3.1	Entiat River Road Bridge (Fire Station Restoration Site)
4.1	Dinkleman Canyon Road Bridge (Dinkleman Canyon Road Restoration Site)
6.8	Entiat National Fish Hatchery
10.1	Mad River
15.2	Potato Creek
16.2	McKenzie Ditch and Diversion Dam (end of Reach 5)
18.4	Stormy Creek
21.2	Dill Creek
23.1	Preston Creek
23.4	Brief Bridge
23.9	Brennegan Creek
25.0	McCrea Creek
25.5	Burns Creek
27.7	Fox Creek
28.1	Fox Creek Campground (start of Reach 1)
28.6	Tommy Creek
28.9	Lake Creek Campground
33.8	Entiat Falls

mileage may not be exact

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February 2011